Some sample project descriptions

Spelman & Morehouse DRP

1. **Title:** Friends, strangers, and Ramsey theory

   Description: Suppose there are six people in a room. Can we always find three people who know each other, or three people who don't? In this project, we will explore this and related questions, and the theory behind these questions, called Ramsey theory.

   Textbook: Ramsey Theory by R. Graham, B. Rothschild and J. Spencer

   Prerequisites: A basic course in mathematical proofs and set theory

2. **Title:** Predicting human behavior using machine learning

   Description: Artificial intelligence has become ubiquitous in today's world. Netflix uses it to recommend content to subscribers. Uber uses it to determine the cost of your ride. Gmail uses it to filter out spam messages. In this project, we will study a particular type of artificial intelligence called machine learning.

   Textbook: Introduction to Machine Learning with Python: A Guide for Data Scientists, by Muller and Guido

   Prerequisites: Linear algebra, basics of probability theory, and some familiarity with the computer programming language Python

3. **Title:** Doubling the ball, and the Banach-Tarski paradox

   Description: Is it possible to take a ball, cut it into pieces, and then reassemble the pieces to get two balls, each of which is identical to the original ball? It turns out that this is indeed possible, and in this project we will explore the mathematics behind this paradox.

   Textbook: The Banach-Tarski Paradox by Stan Wagon

   Prerequisites: Real analysis

4. **Title:** The RSA algorithm, and number theory

   Description: Since ancient civilization, people have relied on cryptography, the art of writing and solving coded messages, to keep their conversations secret from others. In this project, we will study the RSA algorithm, a widely-used approach to encrypting and decrypting communication that is built from fundamental concepts in number theory.

   Textbook: An Introduction to Mathematical Cryptography, by Silverman, Pipher, and Hoffstein

   Prerequisites: Abstract algebra (groups), basic probability theory